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Recovery of Neptune's Near-Polar Stratospheric Hot Spot

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Abstract

Images of Neptune's stratospheric emission in 2003 and 2005 were consistent with the expectation of a warm south pole, the result of decades of continuous solar heating. But in 2006, an unexpected compact hot region was also detected in stratospheric emission at ~70°S latitude and rotating with the 12.2-hour period of the local neutral atmosphere. The possibility that his might be a singular event, e.g. a cometary collision, was disproven when we re-discovered it in single 2007 N-band T-ReCS and 2008 Subaru COMICS acquisition images. These observations show that the spot may be infrequent but not rare. The next step will be to image Neptune at a stratospheric-sensitive wavelength and sample several longitudes in a single rotation to determine whether or not the phenomenon is truly ephemeral or whether it is always present and was simply undersampled in time.

1. Introduction

The 29° tilt of Neptune's rotational axis subjects its atmosphere to substantial seasonal warming and cooling. Stratospheric warming is expected at its south pole which has been exposed to sunlight continuously for over 70 years. Thus, it was not surprising to see enhanced emission from stratospheric methane and ethane at Neptune's south pole in 2003 [1] and 2005 [2], similar to the heating at the south pole of Saturn, which has a similar rotational axial tilt. What was surprising was the 2006 detection [3] of a region of enhanced stratospheric ethane and methane emission offset from the south pole (~ 70°S), rotating with a period of ~12.2 hours (Fig. 1). This period was consistent with the rotation of the neutral atmosphere at this latitude, not with the 16-hour rotation rate of Neptune's magnetic field, arguing against the feature being auroral in origin.

2. Observations

Orton et al. (2007) concluded that the feature was associated with the neutral atmosphere and probably ephemeral, suggesting three possibilities. (1) It could be a rare event, caused by a cometary impact, consistent with a large cometary oxygen delivery suggested by Lellouch et al. [4] (2) It could be a dynamical event similar to the Earth's sudden polar warming, although this only takes place during seasonal changes from cold-polar conditions - unlikely at Neptune's southern summer. (3) Alternatively, it could be a perturbation of Neptune's troposphere which buoyed a rapidly rising body of warm gas, consistent with the sudden appearance of broad, singular cloud features at 70°S [5,6].

The difficulty in characterizing the phenomenon has been that it is very elusive, not appearing in the 2003, 2005 or 2007 images. However, a 12.5-micron (ethane emission) acquisition image in a 2008 Subaru / COMICS run revealed a similar feature. We then re-examined Gemini T-ReCS observations made in 2007, finding no similar phenomenon in science images, but detecting one in an N-band spectroscopic acquisition image which is dominated by 12-micron ethane emission. Thus, a non-polar stratospheric hot spot appears clearly in 3 out of 12 sets that are distinctly separated by time or longitude, with more appearances that are possible if the spot is near the central meridian in noisier acquisition observations. Therefore, although it is unlikely to be as rare as a cometary impact - we cannot argue with any certainty that this phenomenon is either (a) truly ephemeral or (b) long-lived, but undersampled or unrecognized in existing data.

3. Conclusions

The compact hot spot that was detected in stratospheric emission in 2006 is not a rare phenomenon, and therefore unlikely to be the result of a cometary impact. At this point, however, we

cannot argue with any certainty whether this phenomenon is either (a) truly ephemeral or (b) long-lived, but under-sampled or unrecognized in existing data. Observations that sample as close as possible to a full 12.2-hour rotation are sought to clarify this question.

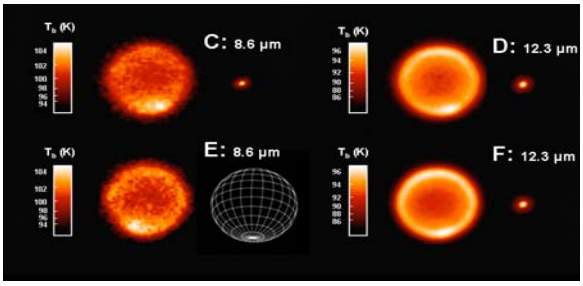

Figure 1: Images of Neptune from 2006 September using the VISIR at the Very Large Telescope. Image C, sensing stratospheric methane emission, was taken first, followed by image D, which senses stratospheric ethane emission This was shortly followed by image F at the same wavelength, then image E in methane emission almost 7 hours later. Images of standard stars are also shown in comparison to gauge the size of the spatial resolution. A graphic shows the orientation of Neptune's disk in all these images. From Ref [3].

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